



Module Interface Specification for RoCam

Team #3, SpaceY

Zifan Si

Jianqing Liu

Mike Chen

Xiaotian Lou

November 16, 2025

1 Revision History

Date	Version	Notes
Nov. 10, 2025	Rev -1	Initial Draft
Nov. 16, 2025	-	Fix Peer Review Comments

2 Symbols, Abbreviations and Acronyms

See SRS Documentation at:

<https://github.com/ZifanSi/vision-guided-tracker/blob/main/docs/SRS/SRS.pdf>

Contents

1	Revision History	i
2	Symbols, Abbreviations and Acronyms	ii
3	Introduction	1
4	Notation	1
5	Module Decomposition	1
6	MIS of Gimbal Abstraction Module	3
6.1	Module	3
6.2	Uses	3
6.3	Syntax	3
6.3.1	Exported Constants	3
6.3.2	Exported Access Programs	3
6.4	Semantics	3
6.4.1	State Variables	3
6.4.2	Environment Variables	3
6.4.3	Assumptions	3
6.4.4	Access Routine Semantics	3
6.4.5	Local Functions	4
7	MIS of Computer Vision Module	4
7.1	Module	4
7.2	Uses	4
7.3	Syntax	4
7.3.1	Exported Constants	4
7.3.2	Exported Access Programs	4
7.4	Semantics	5
7.4.1	State Variables	5
7.4.2	Environment Variables	5
7.4.3	Assumptions	5
7.4.4	Access Routine Semantics	5
7.4.5	Local Functions	5
8	MIS of Tracking Module	5
8.1	Module	5
8.2	Uses	5
8.3	Syntax	5
8.3.1	Exported Constants	5
8.3.2	Exported Access Programs	6
8.4	Semantics	6
8.4.1	State Variables	6

8.4.2	Environment Variables	6
8.4.3	Assumptions	6
8.4.4	Access Routine Semantics	6
8.4.5	Local Functions	6
9	MIS of Output Video Module	6
9.1	Module	6
9.2	Uses	6
9.3	Syntax	7
9.3.1	Exported Constants	7
9.3.2	Exported Access Programs	7
9.4	Semantics	7
9.4.1	State Variables	7
9.4.2	Environment Variables	7
9.4.3	Assumptions	7
9.4.4	Access Routine Semantics	7
9.4.5	Local Functions	7
10	MIS of Recording Module	7
10.1	Module	7
10.2	Uses	7
10.3	Syntax	8
10.3.1	Exported Constants	8
10.3.2	Exported Access Programs	8
10.4	Semantics	8
10.4.1	State Variables	8
10.4.2	Environment Variables	8
10.4.3	Assumptions	8
10.4.4	Access Routine Semantics	8
10.4.5	Local Functions	9
11	MIS of State Management Module	9
11.1	Module	9
11.2	Uses	9
11.3	Syntax	9
11.3.1	Exported Constants	9
11.3.2	Exported Access Programs	9
11.4	Semantics	9
11.4.1	State Variables	9
11.4.2	Environment Variables	9
11.4.3	Assumptions	9
11.4.4	Access Routine Semantics	9
11.4.5	Local Functions	10

12 MIS of API Gateway Module	10
12.1 Module	10
12.2 Uses	10
12.3 Syntax	10
12.3.1 Exported Constants	10
12.3.2 Exported Access Programs	11
12.4 Semantics	11
12.4.1 State Variables	11
12.4.2 Environment Variables	11
12.4.3 Assumptions	11
12.4.4 Access Routine Semantics	11
12.4.5 Local Functions	11
13 MIS of Preview Module	11
13.1 Module	11
13.2 Uses	11
13.3 Syntax	11
13.3.1 Exported Constants	11
13.3.2 Exported Access Programs	11
13.4 Semantics	12
13.4.1 State Variables	12
13.4.2 Environment Variables	12
13.4.3 Assumptions	12
13.4.4 Access Routine Semantics	12
13.4.5 Local Functions	12
14 MIS of Manual Control Module	12
14.1 Module	12
14.2 Uses	12
14.3 Syntax	12
14.3.1 Exported Constants	12
14.3.2 Exported Access Programs	12
14.4 Semantics	12
14.4.1 State Variables	12
14.4.2 Environment Variables	12
14.4.3 Assumptions	13
14.4.4 Access Routine Semantics	13
14.4.5 Local Functions	13
15 MIS of Recording Management Module	13
15.1 Module	13
15.2 Uses	13
15.3 Syntax	13
15.3.1 Exported Constants	13
15.3.2 Exported Access Programs	13

15.4	Semantics	13
15.4.1	State Variables	13
15.4.2	Environment Variables	13
15.4.3	Assumptions	13
15.4.4	Access Routine Semantics	13
15.4.5	Local Functions	13
16	MIS of Configuration Module	13
16.1	Module	13
16.2	Uses	14
16.3	Syntax	14
16.3.1	Exported Constants	14
16.3.2	Exported Access Programs	14
16.4	Semantics	14
16.4.1	State Variables	14
16.4.2	Environment Variables	14
16.4.3	Assumptions	14
16.4.4	Access Routine Semantics	14
16.4.5	Local Functions	14
17	Appendix	16

3 Introduction

The following document details the Module Interface Specifications for Rocam: High Performance Vision-Guided Rocket Tracker.

Complementary documents include the System Requirement Specifications and Module Guide. The full documentation and implementation can be found at:

<https://github.com/ZifanSi/vision-guided-tracker>

4 Notation

The structure of the MIS for modules comes from Hoffman and Strooper (1995), with the addition that template modules have been adapted from Ghezzi et al. (2003). The mathematical notation comes from Chapter 3 of Hoffman and Strooper (1995). For instance, the symbol $:=$ is used for a multiple assignment statement and conditional rules follow the form $(c_1 \Rightarrow r_1 | c_2 \Rightarrow r_2 | \dots | c_n \Rightarrow r_n)$.

The following table summarizes the primitive data types used by RoCam.

Data Type	Notation	Description
character	char	a single symbol or digit
integer	\mathbb{Z}	a number without a fractional component in $(-\infty, \infty)$
natural number	\mathbb{N}	a number without a fractional component in $[1, \infty)$
real	\mathbb{R}	any number in $(-\infty, \infty)$

The specification of RoCam uses some derived data types: sequences, strings, and tuples. Sequences are lists filled with elements of the same data type. Strings are sequences of characters. Tuples contain a list of values, potentially of different types. In addition, RoCam uses functions, which are defined by the data types of their inputs and outputs. Local functions are described by giving their type signature followed by their specification.

5 Module Decomposition

The following table is taken directly from the Module Guide document for this project.

Level 1	Level 2
Jetson Module	Gimbal Abstraction Module Computer Vision Module Tracking Module Output Video Module Recording Module State Management Module API Gateway Module Serial Abstraction Module Video Stream Abstraction Module
UI Module	Preview Module Manual Control Module Recording Management Module Configuration Module

Table 1: Module Hierarchy

6 MIS of Gimbal Abstraction Module

6.1 Module

Gimbal

6.2 Uses

This module uses the Serial Abstraction Module (M14 described in the MG).

6.3 Syntax

6.3.1 Exported Constants

This module does not have any exported constants.

6.3.2 Exported Access Programs

Name	In	Out	Exceptions
move_deg	tilt: f32, pan: f32	-	gimbalCommunicationError
measure_deg	-	tilt: f32, pan: f32	gimbalCommunicationError
control_arm_led	enabled: bool	-	gimbalCommunicationError
control_status_led	enabled: bool	-	gimbalCommunicationError

6.4 Semantics

6.4.1 State Variables

- persistent connection to the gimbal

6.4.2 Environment Variables

- This module interacts with an external gimbal device.

6.4.3 Assumptions

6.4.4 Access Routine Semantics

move_deg(tilt: f32, pan: f32):

- transition: sends the tilt and pan angles to the gimbal
- output: None
- exception: gimbalCommunicationError

measure_deg():

- transition: retrieves the tilt and pan angle measurements from the gimbal

- output: (tilt: f32, pan: f32)
- exception: gimbalCommunicationError

control_arm_led(enabled: bool):

- transition: controls the arm LED on the gimbal
- output: None
- exception: gimbalCommunicationError

control_status_led(enabled: bool):

- transition: controls the status LED on the gimbal
- output: None
- exception: gimbalCommunicationError

6.4.5 Local Functions

7 MIS of Computer Vision Module

7.1 Module

CV

7.2 Uses

This module uses the Video Stream Abstraction Module (M15 described in the MG).

7.3 Syntax

7.3.1 Exported Constants

- WIDTH: width of the video feed (in pixels)
- HEIGHT: height of the video feed (in pixels)

7.3.2 Exported Access Programs

Name	In	Out	Exceptions
get_frame	-	frame	cameraError
get_rocket_location	frame	x: f32, y: f32	noRocketFound, cameraError

7.4 Semantics

7.4.1 State Variables

- computer vision model
- persistent connection to the camera sensor

7.4.2 Environment Variables

- This module interacts with an external camera sensor.

7.4.3 Assumptions

7.4.4 Access Routine Semantics

`get_frame()`:

- transition: retrieves a frame from the camera sensor
- output: frame
- exception: `cameraError`

`get_rocket_location(frame)`:

- transition: analyzes the frame to find the rocket
- output: (x: f32, y: f32)
- exception: `noRocketFound`, `cameraError`

7.4.5 Local Functions

8 MIS of Tracking Module

8.1 Module

Tracking

8.2 Uses

This module uses the Computer Vision Module (7) and the Gimbal Abstraction Module (6).

8.3 Syntax

8.3.1 Exported Constants

This module does not have any exported constants.

8.3.2 Exported Access Programs

Name	In	Out	Exceptions
step	-	-	-

8.4 Semantics

8.4.1 State Variables

- PID parameters for controlling the gimbal

8.4.2 Environment Variables

None

8.4.3 Assumptions

8.4.4 Access Routine Semantics

step():

- transition:
 1. Retrieve the current gimbal angle from the Gimbal Abstraction Module.
 2. Get the location of the rocket from the Computer Vision Module.
 3. Calculate the desired gimbal angle using the PID algorithm.
 4. Send the desired gimbal angle to the Gimbal Abstraction Module.
- output: None
- exception: None

8.4.5 Local Functions

9 MIS of Output Video Module

9.1 Module

videoOut

9.2 Uses

This module uses the Video Stream Abstraction Module (M15 described in the MG).

9.3 Syntax

9.3.1 Exported Constants

9.3.2 Exported Access Programs

Name	In	Out	Exceptions
output_frame	states	-	outputDeviceError

9.4 Semantics

9.4.1 State Variables

None

9.4.2 Environment Variables

This module displays the frame on the screen connected to the Jetson.

9.4.3 Assumptions

9.4.4 Access Routine Semantics

output_frame(states):

- transition:
 1. Retrieve the frame from the Computer Vision Module.
 2. Retrieve the location of the rocket from the Computer Vision Module.
 3. Crop the frame so the rocket is in the center of the frame.
 4. Overlay the states on the cropped frame.
 5. Display the cropped frame on the screen connected to the Jetson.
- output: None
- exception: outputDeviceError

9.4.5 Local Functions

10 MIS of Recording Module

10.1 Module

recording

10.2 Uses

This module uses the Video Stream Abstraction Module (M15 described in the MG).

10.3 Syntax

10.3.1 Exported Constants

10.3.2 Exported Access Programs

Name	In	Out	Exceptions
start_recording	-	-	recordingError
stop_recording	-	-	recordingError
list_recordings	-	recordings: list[Recording]	
delete_recording	recordingId: str	-	

10.4 Semantics

10.4.1 State Variables

- recording status

10.4.2 Environment Variables

This module interacts with the file system to record the video and log files.

10.4.3 Assumptions

10.4.4 Access Routine Semantics

start_recording():

- transition: starts recording the video and log files
- output: None
- exception: recordingError

stop_recording():

- transition: stops recording the video and log files
- output: None
- exception: recordingError

list_recordings():

- transition: retrieves the list of recordings from the file system
- output: recordings: list[Recording]
- exception: None

delete_recording(recordingId: str):

- transition: deletes the recording from the file system
- output: None
- exception: None

10.4.5 Local Functions

11 MIS of State Management Module

11.1 Module

stateManagement

11.2 Uses

This module uses the Recording Module (10), Tracking Module (8), and Output Video Module (9).

11.3 Syntax

11.3.1 Exported Constants

This module does not have any exported constants.

11.3.2 Exported Access Programs

Name	In	Out	Exceptions
arm	-	-	-
disarm	-	-	-
manual_control	direction	-	-

11.4 Semantics

11.4.1 State Variables

- armed status

11.4.2 Environment Variables

None

11.4.3 Assumptions

11.4.4 Access Routine Semantics

arm():

- transition:

1. Set the armed state variable to true.
2. Start a loop in the background, which does the following until the armed state variable is set to false:
 - (a) Call "get_frame" from the Computer Vision Module.
 - (b) Call "get_rocket_location" from the Computer Vision Module.
 - (c) Call "step" from the Tracking Module to adjust the gimbal to keep the rocket in the center of the frame.
 - (d) Call "output_frame" from the Output Video Module to display the frame on the screen.

- output: None
- exception: None

disarm():

- transition: sets the armed state variable to false
- output: None
- exception: None

manual_control(direction):

- transition: adjusts the gimbal to the given direction if the armed state variable is false
- output: None
- exception: None

11.4.5 Local Functions

12 MIS of API Gateway Module

12.1 Module

apiGateway

12.2 Uses

This module uses the State Management Module ([11](#)) .

12.3 Syntax

12.3.1 Exported Constants

This module does not have any exported constants.

12.3.2 Exported Access Programs

Name	In	Out	Exceptions
start_server	-	-	-

12.4 Semantics

12.4.1 State Variables

None

12.4.2 Environment Variables

None

12.4.3 Assumptions

12.4.4 Access Routine Semantics

start_server():

- transition: starts the api server and listens for requests from the web interface.
- output: None
- exception: None

12.4.5 Local Functions

13 MIS of Preview Module

13.1 Module

preview

13.2 Uses

This module uses the API Gateway Module ([12](#)).

13.3 Syntax

13.3.1 Exported Constants

This module does not have any exported constants.

13.3.2 Exported Access Programs

This module does not have any exported access programs

13.4 Semantics

13.4.1 State Variables

None

13.4.2 Environment Variables

- This module shows the preview on the screen.

13.4.3 Assumptions

13.4.4 Access Routine Semantics

13.4.5 Local Functions

14 MIS of Manual Control Module

14.1 Module

manualControl

14.2 Uses

This module uses the State Management Module ([11](#)).

14.3 Syntax

14.3.1 Exported Constants

This module does not have any exported constants.

14.3.2 Exported Access Programs

This module does not have any exported access programs

14.4 Semantics

14.4.1 State Variables

None

14.4.2 Environment Variables

- This module shows the manual control interface on the screen.

14.4.3 Assumptions

14.4.4 Access Routine Semantics

14.4.5 Local Functions

15 MIS of Recording Management Module

15.1 Module

recordingManagement

15.2 Uses

This module uses the Recording Module ([10](#)).

15.3 Syntax

15.3.1 Exported Constants

This module does not have any exported constants.

15.3.2 Exported Access Programs

This module does not have any exported access programs

15.4 Semantics

15.4.1 State Variables

- recording list

15.4.2 Environment Variables

- This module manages the recordings.

15.4.3 Assumptions

15.4.4 Access Routine Semantics

15.4.5 Local Functions

16 MIS of Configuration Module

16.1 Module

configuration

16.2 Uses

This module uses the Recording Management Module ([15](#)).

16.3 Syntax

16.3.1 Exported Constants

This module does not have any exported constants.

16.3.2 Exported Access Programs

This module does not have any exported access programs

16.4 Semantics

16.4.1 State Variables

- configuration settings

16.4.2 Environment Variables

- This module manages the configuration settings.

16.4.3 Assumptions

16.4.4 Access Routine Semantics

16.4.5 Local Functions

References

- Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. *Fundamentals of Software Engineering*. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2003.
- Daniel M. Hoffman and Paul A. Strooper. *Software Design, Automated Testing, and Maintenance: A Practical Approach*. International Thomson Computer Press, New York, NY, USA, 1995. URL <http://citeseer.ist.psu.edu/428727.html>.

17 Appendix

Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Problem Analysis and Design.

The purpose of reflection questions is to give you a chance to assess your own learning and that of your group as a whole, and to find ways to improve in the future. Reflection is an important part of the learning process. Reflection is also an essential component of a successful software development process.

Reflections are most interesting and useful when they're honest, even if the stories they tell are imperfect. You will be marked based on your depth of thought and analysis, and not based on the content of the reflections themselves. Thus, for full marks we encourage you to answer openly and honestly and to avoid simply writing “what you think the evaluator wants to hear.”

Please answer the following questions. Some questions can be answered on the team level, but where appropriate, each team member should write their own response:

1. What went well while writing this deliverable?
2. What pain points did you experience during this deliverable, and how did you resolve them?
3. Which of your design decisions stemmed from speaking to your client(s) or a proxy (e.g. your peers, stakeholders, potential users)? For those that were not, why, and where did they come from?
4. While creating the design doc, what parts of your other documents (e.g. requirements, hazard analysis, etc), if any, needed to be changed, and why?
5. What are the limitations of your solution? Put another way, given unlimited resources, what could you do to make the project better? (LO_ProbSolutions)
6. Give a brief overview of other design solutions you considered. What are the benefits and tradeoffs of those other designs compared with the chosen design? From all the potential options, why did you select the documented design? (LO_Explores)